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Godwin Asibor

Department of Environmental
Management and Toxicology,
Federal University of Petroleum
Resources Effurun, Delta State,
Nigeria

Funso Adeniyi

Department of Zoology, Obafemi
Awolowo University, Ile-Ife,
Nigeria

Zooplankton composition and community structure in Asejire Reservoir, Southwest Nigeria

Godwin Asibor and Funso Adeniyi

Abstract

The zooplankton of Asejire reservoir was identified and its community structure assessed between April 2017 and March 2018 in nine selected sites. Three stations each were established along the horizontal axis of the reservoir, covering the riverine, transition and lacustrine zones of the lake. The taxa richness, diversity, and evenness indices were calculated using Shannon-Wiener, Simpson and Margalef indices. A total of 146 species of zooplankton was recorded comprising Rotifera (80), Copepoda (24), Cladocera (22), Protozoa (7), Ostracoda (7) and Insecta larvae (6). *Notholca foliacea*, *Brachionus angularis*, *B. budapestinensis*, *B. calyciflorus*, *B. caudatus*, *B. cochlearis*, *B. dimidiatus*, *B. patulus* and *Bosminia longirostris* were recorded in all the stations while 17% of the occurring species were recorded only at one stations each. Rotifers accounted for over 50% of the total occurrence, followed by the Cladocera (17%) and Copepoda (16%). The Protozoan were the least occurring species with 2%, followed by Ostracoda (4.63%) and Insecta (3.96%). The riverine zone had the highest occurrence of zooplankton species, whereas the lacustrine zone had the lowest occurrence. The presence of some pollution indicator species is a cause of concern and there is the need to ensure holistic and effective monitoring measure to safeguard the reservoir from further anthropogenic intrusion from the receiving rivers and streams.

Keywords: Zooplankton, abundance, diversity, dominance, species occurrence, pollution

1. Introduction

Plankton is a collective term used for a mixed group of tiny and in most cases, microscopic living organisms in water bodies ^[1, 2] and plays a vital role in aquatic food web ^[3]. Photosynthesizing plankton are referred to as phytoplankton, while the animal components are referred to as the zooplankton. They include both small protozoans and large metazoans. According to ^[2] inland freshwaters derives its members mainly from the Protozoan, Rotifers, Cladoceran and Copepods, with occasional minor contributed from ostracod crustaceans, arachnids, larval molluscs and insect. Holoplankton zooplankton complete their life cycle as plankton while meroplanktonic zooplankton spend part of their life cycle in the plankton stage before metamorphosing to either the nekton or to benthic organisms.

Zooplanktons can be used as a bio-indicator of water quality in aquatic ecosystems ^[4, 5, 6] reported it to be more appropriate as a biological index of water quality than fish or other higher aquatic animals in water ecosystem due to their position in the aquatic food chain and rapid changes in the environment compared to other groups of organisms in the aquatic ecosystem. Species such as *Asplanchna brightwelli*, *Brachionus angularis*, *B. falcatus*, *Filinia terminalis* and *Polyarthra remata* have been linked with eutrophic water bodies ^[7].

Asejire Reservoir was created primarily for water supply and fisheries ^[8], but over the years, it has served a wide range of other purposes such as fishing, irrigation, transportation, research, etc. ^[9]. Some previous studies on the zooplankton of Asejire reservoir and associated rivers includes the works of ^[8] on River Oshun, ^[10, 11, 12] on Asejire Reservoir and ^[13] on Oshun River basins. In order to properly manage reservoirs or lakes, current and updated status of monitoring of zooplankton communities is needed to predictively model the ecosystem. This study is therefore aimed at determining the present status of the composition, distribution pattern, abundance and community structure of the zooplankton fauna of the Reservoir.

2. Materials and Methods**2.1 Study Area**

The study area is located in the equatorial tropical climate ^[14], characterized by average annual rainfall of 100±40cm, temperature of 28±1.04 °C) and relative humidity ranging from 58% in the dry season to above 80% in the rainy season.

Corresponding Author:**Godwin Asibor**

Department of Environmental
Management and Toxicology,
Federal University of Petroleum
Resources Effurun, Delta State,
Nigeria

The surrounding vegetation is lowland tropical rainforest and dense savannah, woodland at the northern fringe, but human interference and persistent annual bush burning have reduced the natural vegetation to one described by [15] as forest regrowth. The Reservoir extend from longitudes 004° 07'017"E - 004° 08'925"E and from latitudes 07° 21'48"N and 07° 26'84"N (Figure 1). The reservoir is a manmade lake that was created in 1970 by the impoundment of River Osun to provide potable water for the city Ibadan and environs [7] and officially opened in 1972. Other ancillary benefits such as fishing, recreation, agriculture, etc. have since emerged after the dam creation [8]. The reservoir receives the bulk of its water input from two rivers, Rivers Osun and its main tributary River Oba. The catchment area of the dam is 7,800 km² and the impounded area is 23.42 km². The surface area of the reservoir is about 24 km². Its gross storage capacity is approximately 7,403.4 million litres per day while its discharge capacity is 136.26 million litres per day with maximum water capacity of about 675 m³. The reservoir

supply water to more than two million inhabitants of Oyo and Osun States in the Southwestern part of Nigeria.

2.2 Selection, Description of sampling stations and Sample Collection

A reconnaissance survey of the Reservoir was conducted to identify sampling stations based on important ecological landmarks. Nine sampling sites (Stations A, B, C, D, E, F, G, H and I) were established along the course of the reservoir based on some ecological landmarks. Three stations each were established along the horizontal axis of the reservoir, covering the upper basin (riverine zone), middle basin (transition zone) and lower basin (lacustrine zone) of the lake (Figure 1) using a global positioning system (GPS) handset to determine the grid coordinates of the sampling sites. Samples were collected from April 2017 to March 2018. Samples were collected at each station by filtering 100 litres of water through a plankton net of 60 µm mesh size and reducing it to a 30 ml. The samples were preserved in 5% formalin solution.

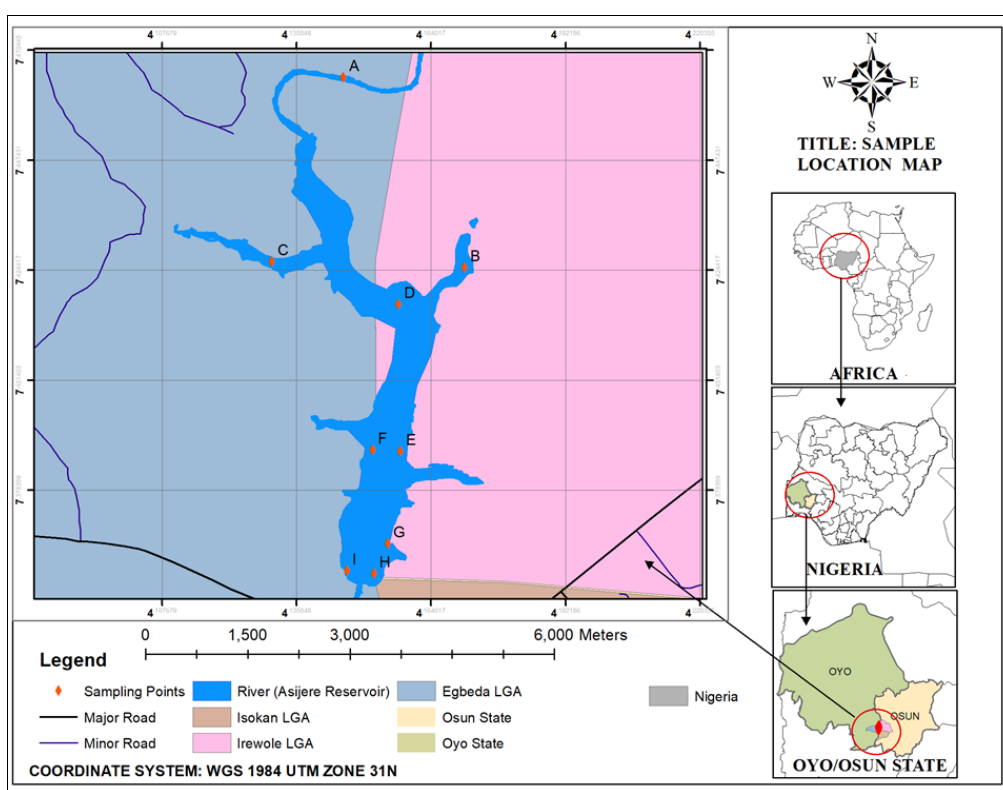


Fig 1: Asejire reservoir showing locations of sampling stations

2.3 Laboratory analyses

The 30 ml sample was reduced to 5 ml and observed under a compound microscope. Zooplankton organisms were identified using guides by [16, 17, 18, 19, 20, 21, 22, 23]. Zooplankton abundance were computed from the final concentrated volume in relation to the original volume of water strained through the plankton net. Species community structure and diversity indices was calculated using Simpson's dominance index (S). Abundance of each species was estimated based by multiplying the number in the final concentrate volume by 1000 and expressed as Organism/L (Org/L).

2.4 Statistical analysis

Shannon-Wiener, Simpson and Margelef indices were deployed to enumerate the taxa richness, diversity, and evenness indices using the Palaeontological Statistics [24],

Statistical Ecology [25] and Statistical Package for Social Sciences Software package.

3. Results

3.1 Species Occurrence and Abundance

A total of one hundred and forty-six (146) species of zooplankton was recorded. The fauna comprised eighty (80) species of Rotifera, twenty four (24) species of Copepoda, twenty two (22) species of Cladocera, Seven species (07) of Protozoa, seven (07) species of Ostracoda and six (06) species of Insecta larvae (Table 1). *Agnotholca foliacea*, *Brachionus angularis*, *B. budapestinensis*, *B. calyciflorus*, *B. caudatus*, *B. cochlearis*, *B. dimidiatus*, *B. patulus* and *Bosminia longirostris* were recorded in all the stations while about 17% of the occurring species were only recorded at one stations each.

The Rotifers accounted for over fifty percent of the total occurrence of the zooplankton at Asejire Reservoir. They were followed by the Cladocera (17%) and Copepoda (16.01%) as shown in Table 2. The Protozoan were the least occurring species with 2.14%, followed by Ostracoda (3.63%) and Insecta (3.96%). The highest species occurrence of zooplankton was recorded at the upper basin (riverine zone) surface (Stations A, C and B), followed by the middle basin

surface (transition zone) Stations E, D and F. The lowest species occurrence of zooplankton was recorded at the lacustrine zone (Stations G, H and I). The highest species occurrence was Station 1, followed by Station 2, while the station with the least occurrence was Station 9. In all, Rotifera, Copepoda, Cladocera, Insecta and Ostracoda were recorded at all stations, while Protozoa were not recorded in three of the nine stations (Stations D, F and I).

Table 1: Zooplankton different species occurrence at Asejire Reservoir sampling stations

Taxa	Sampling Stations									Total	%
	A	B	C	D	E	F	G	H	I		
<i>Argonotholca foliacea</i>	400	200	100	75	25	25	100	50	25	1000	1.88
<i>Argonotholca</i> sp.	100	50	100	0	0	0	0	0	0	250	0.47
<i>Hexarthra</i> sp.	0	25	0	0	0	0	25	50	50	150	0.28
<i>Branchionus angularis</i>	400	100	200	50	50	100	50	25	25	1000	1.88
<i>Branchionus bennini</i>	50	50	100	25	50	100	0	0	0	375	0.71
<i>Branchionus budapestinensis</i>	25	150	50	25	150	50	100	25	25	600	1.13
<i>Branchionus calyciflorus</i>	250	25	150	750	50	100	50	100	25	1500	2.82
<i>Branchionus caudatus</i>	50	100	150	50	25	100	50	25	75	625	1.18
<i>Branchionus cochlearis</i>	100	50	200	100	150	25	75	25	25	750	1.41
<i>Branchionus dimidiatus</i>	100	100	100	50	50	25	100	50	50	625	1.18
<i>Branchionus falcatus</i>	200	100	400	200	400	250	50	25	25	1650	3.10
<i>Branchionus patulus</i>	100	25	50	50	25	50	100	25	50	475	0.89
<i>Branchionus plicatilis</i>	50	25	50	0	75	50	25	75	25	375	0.71
<i>Branchionus quadridentatus</i>	100	0	100	25	0	0	25	0	0	250	0.47
<i>Branchionus</i> sp	100	0	0	0	50	0	25	0	0	175	0.33
<i>Branchionus urceus</i>	25	50	0	75	0	25	25	0	0	200	0.38
<i>Anuraeopsis fissa</i>	200	50	400	50	100	50	25	0	0	875	1.65
<i>Anuraeopsis navicula</i>	50	25	25	0	50	0	0	0	0	150	0.28
<i>Anuraeopsis racenensis</i>	100	50	25	0	25	0	0	0	0	200	0.38
<i>Keratella cochlearis cochlearis</i>	200	150	450	50	150	50	25	0	25	1100	2.07
<i>Keratella cochlearis macracantha</i>	850	900	950	50	0	0	0	0	0	2750	5.17
<i>Keratella crassa</i>	250	50	450	50	50	25	25	0	0	900	1.69
<i>Keratella lenzi</i>	350	400	650	50	25	50	25	50	0	1600	3.01
<i>Keratella tropica</i>	750	900	450	150	50	100	0	0	25	2425	4.56
<i>Macrochaetus longipes</i>	25	0	25	0	25	0	0	0	0	75	0.14
<i>Squatinella mutica</i>	0	25	0	0	25	0	0	0	0	50	0.09
<i>Notholca labis</i>	0	75	150	0	25	0	0	25	0	275	0.52
<i>Platylas leloupi</i>	25	0	0	100	0	0	0	0	0	125	0.24
<i>Platylas quadricornis</i>	75	25	0	100	25	50	0	0	0	275	0.52
<i>Synchaeta pectinata</i>	50	0	0	150	100	50	25	0	0	375	0.71
<i>Synchaeta tremula oblonga</i>	250	525	25	50	25	25	100	25	0	1025	1.93
<i>Rotaria neptunia</i>	0	75	150	50	50	0	0	25	0	350	0.66
<i>Polyarthra remata</i>	0	0	0	150	100	150	25	0	0	425	0.80
<i>Mytilina ventralis</i>	0	0	0	0	0	0	0	0	50	50	0.09
<i>Lecane inopinata</i>	25	0	0	0	0	0	0	0	0	25	0.05
<i>Lepadella cristata</i>	0	25	0	0	50	100	0	0	0	175	0.33
<i>Lepadella patella</i>	250	0	300	25	0	0	25	0	0	600	1.13
<i>Lepadella similis</i>	0	50	50	0	25	0	0	25	0	150	0.28
<i>Lepadella uncinata</i>	50	0	0	0	0	0	0	0	0	50	0.09
<i>Lecane bulla</i>	450	0	100	50	100	25	25	0	25	775	1.46
<i>Lecane leontina</i>	50	75	0	0	25	50	25	0	0	225	0.42
<i>Lecane luna</i>	250	0	0	50	0	25	25	0	0	350	0.66
<i>Lecane lunaris</i>	50	250	0	0	0	0	0	0	0	300	0.56
<i>Lecane quadridentata</i>	450	0	0	25	100	0	50	0	0	625	1.18
<i>Lecane signifera</i>	50	0	0	0	0	0	0	0	0	50	0.09
<i>Lecane styrax</i>	0	50	0	0	0	25	0	0	0	75	0.14
<i>Lecane symпода</i>	0	25	0	0	0	0	0	0	0	25	0.05
<i>Monostyla bulla styrax</i>	100	25	0	0	75	0	25	0	0	225	0.42
<i>Monostyla lunaris</i>	75	75	25	0	0	100	25	50	0	350	0.66
<i>Trichocerca bicristata</i>	50	50	100	50	50	25	25	25	0	375	0.71
<i>Trichocerca capusilla</i>	0	0	0	25	0	0	0	0	0	25	0.05
<i>Trichocerca chattoni</i>	100	0	0	0	0	0	0	0	0	100	0.19
<i>Trichocerca cylindrica</i>	0	100	50	0	25	0	0	0	0	175	0.33
<i>Trichocerca elongata</i>	50	100	0	0	0	0	0	0	0	150	0.28

<i>Trichocerca flagellata</i>	0	50	0	0	0	0	0	0	0	50	0.09
<i>Trichocerca insulana</i>	75	25	100	0	0	25	0	0	0	225	0.42
<i>Trichocerca parcellus</i>	150	50	0	250	400	50	0	0	0	900	1.69
<i>Trichocerca similis</i>	0	100	0	50	0	0	25	25	0	200	0.38
<i>Trichocerca tigris</i>	25	0	0	0	0	0	0	0	0	25	0.05
<i>Cephalodella mucromata</i>	0	0	75	0	25	0	25	0	0	125	0.24
<i>Enteroplea lacustris</i>	0	0	0	25	0	25	0	0	0	50	0.09
<i>Ascomorpa caudatus</i>	50	100	200	0	25	0	25	0	0	400	0.75
<i>Ascomorpa ovalis</i>	100	250	150	50	100	100	25	0	50	825	1.55
<i>Ascomorpa saltans</i>	100	0	25	0	0	0	0	0	0	125	0.24
<i>Asplanchna brightwelli</i>	100	50	50	0	0	0	0	0	0	200	0.38
<i>Asplanchna herrickii</i>	50	50	100	0	25	25	0	25	0	275	0.52
<i>Asplanchna priodonta</i>	25	0	75	0	25	0	0	25	0	150	0.28
<i>Asplanchna sieboldi</i>	0	0	25	0	25	0	0	0	0	50	0.09
<i>Beauchampiella eudactylota</i>	0	25	0	0	0	0	0	0	0	25	0.05
<i>Euchlanis triquetra</i>	25	0	0	0	0	0	0	0	0	25	0.05
<i>Pompholyx complanata</i>	0	0	0	50	0	100	0	0	0	150	0.28
<i>Albertia sp</i>	100	0	50	0	25	0	0	25	0	200	0.38
<i>Eothinia sp</i>	150	50	100	0	75	0	25	0	0	400	0.75
<i>Testudinella berzinsi</i>	0	75	100	0	0	75	0	0	0	250	0.47
<i>Polyantra vulgaris</i>	50	0	0	0	0	0	0	0	0	50	0.09
<i>Hexarthra mira</i>	25	0	0	200	250	50	0	0	0	525	0.99
<i>Testudinella patina</i>	0	0	0	0	0	0	0	0	50	50	0.09
<i>Filinia apoliensis</i>	0	0	0	0	0	0	150	200	50	400	0.75
<i>Filinia longiseta</i>	25	25	50	25	0	0	25	0	0	150	0.28
<i>Filinia terminalis</i>	100	0	0	0	0	0	0	0	0	100	0.19
<i>Moina micrura</i>	150	50	100	0	50	25	0	0	0	375	0.71
<i>Moinodaphnia macleayi</i>	150	25	50	50	25	25	75	0	0	400	0.75
<i>Moina rostrata</i>	0	50	0	0	0	0	0	0	0	50	0.09
<i>Diaphanosoma excisum</i>	0	50	0	50	100	50	0	0	0	250	0.47
<i>Diaphanosoma brachyurum</i>	200	50	25	50	100	100	25	25	0	575	1.08
<i>Diaphanosoma sarsi</i>	150	50	150	50	25	0	0	0	0	425	0.80
<i>Scapholeberis kingi</i>	100	25	50	50	25	25	75	0	0	350	0.66
<i>Scapholeberis mucronata</i>	0	50	100	50	50	0	0	0	0	250	0.47
<i>Simocephalus vetulus</i>	0	50	250	50	25	0	0	0	0	375	0.71
<i>Daphnia longiremis</i>	0	50	150	50	25	0	0	0	0	275	0.52
<i>Daphnia longispina</i>	100	50	50	25	50	0	0	50	0	325	0.61
<i>Daphnia magna</i>	150	50	150	50	25	0	0	0	0	425	0.80
<i>Daphnia middendorffiana</i>	50	100	150	50	25	0	0	0	0	375	0.71
<i>Daphnia parvula</i>	50	150	100	50	0	100	25	50	0	525	0.99
<i>Daphnia pulex</i>	100	250	50	50	100	100	25	0	0	675	1.27
<i>Chydorus sphaericus</i>	150	0	50	0	0	0	0	0	0	200	0.38
<i>Ceriodaphnia lacustris</i>	50	0	100	0	25	0	0	0	0	175	0.33
<i>Ceriodaphnia reticulata</i>	100	0	50	0	0	0	0	0	0	150	0.28
<i>Bosminia longirostris</i>	250	150	100	50	100	100	25	50	100	925	1.74
<i>Scapholeberis kingi</i>	50	0	0	0	25	0	0	0	0	75	0.14
<i>Holopedium gibberum</i>	0	0	0	0	0	0	25	0	0	25	0.05
<i>Alona affinis</i>	0	50	0	100	25	50	25	0	0	250	0.47
<i>Thermocyclops consimilis</i>	100	25	0	50	100	50	25	50	0	400	0.75
<i>Thermocyclops crassus</i>	50	0	100	25	0	0	0	0	0	175	0.33
<i>Thermocyclops ermini</i>	0	0	0	25	0	0	0	0	0	25	0.05
<i>Thermocyclops inopinus</i>	0	0	0	100	0	50	0	0	0	150	0.28
<i>Thermocyclops neglectus</i>	50	0	0	25	0	0	0	0	0	75	0.14
<i>Microcyclops varicans</i>	25	0	0	0	0	0	0	0	0	25	0.05
<i>Eucyclops macrurus</i>	0	0	75	0	25	0	0	25	0	125	0.24
<i>Halicyclops korodiensis</i>	75	25	0	0	0	25	25	0	0	150	0.28
<i>Halicyclops troglodytes</i>	0	0	25	0	0	0	0	0	0	25	0.05
<i>Calanus sp.</i>	50	0	25	0	25	25	0	0	0	125	0.24
<i>Copepod (calanoid) nauplius</i>	200	100	50	50	0	0	0	25	25	450	0.85
<i>Copepod (cyclopoid) nauplius</i>	650	450	550	0	100	100	50	0	0	1900	3.57
<i>Diaptomus sp.</i>	50	100	150	50	100	50	50	25	0	575	1.08
<i>Mesocyclops edax</i>	50	0	50	0	0	0	0	0	0	100	0.19
<i>Mesocyclops ogunnus</i>	0	100	100	0	50	0	25	0	0	275	0.52
<i>Paracyclops chiltoni</i>	0	25	0	250	450	200	25	0	0	950	1.79
<i>Senecalla calanoides</i>	0	0	0	50	100	100	0	0	0	250	0.47
<i>Bryocamptus minutus</i>	50	0	25	0	0	0	0	0	0	75	0.14
<i>Cleptocampus sp.</i>	50	25	0	25	0	25	0	50	0	175	0.33

<i>Nauplius larva</i>	200	450	100	50	50	100	75	25	0	1050	1.98
<i>Metacyclops minutus</i>	0	50	0	0	100	0	0	0	0	150	0.28
<i>Mesocyclops leuckarti</i>	0	50	0	0	25	0	0	0	0	75	0.14
<i>Diacyclops thomasi</i>	50	150	150	50	100	50	50	25	0	625	1.18
<i>Megacyclops viridis</i>	50	100	150	50	50	50	50	25	0	525	0.99
<i>Chaoborus sp. (larvae)</i>	100	50	50	0	25	0	0	0	0	225	0.42
<i>Ceratopogonid larva</i>	50	0	100	0	0	0	0	25	0	175	0.33
<i>Chironomid sp.</i>	50	0	25	100	0	150	0	0	0	325	0.61
<i>Coenagrion pulchellum</i>	150	50	100	0	50	75	100	75	150	750	1.41
<i>Hesperocorixa obliqua</i>	0	25	25	0	25	0	0	0	0	75	0.14
<i>Eristalis larva</i>	0	0	50	0	0	25	0	0	0	75	0.14
<i>Vermamoeba sp.</i>	50	100	0	0	25	0	25	0	0	200	0.38
<i>Vermamoeba vermiformis</i>	50	0	50	0	0	0	0	0	0	100	0.19
<i>Actinophrys sp.</i>	0	100	50	0	0	0	0	0	0	150	0.28
<i>Amoeba radiata</i>	50	100	0	0	0	0	0	0	0	150	0.28
<i>Arcella sp.</i>	0	0	0	0	0	0	0	100	0	100	0.19
<i>Centropyxis sp.</i>	0	0	0	0	0	0	0	50	0	50	0.09
<i>Loxodes magnus</i>	0	0	0	0	0	0	25	0	0	25	0.05
<i>Chrissia humilis</i>	0	25	0	0	0	50	0	25	0	100	0.19
<i>Hemicypris ovata</i>	0	0	25	0	0	0	0	0	0	25	0.05
<i>Heterocypris makua</i>	0	0	0	0	0	0	100	50	25	175	0.33
<i>Stenocypris derupta</i>	0	50	25	0	0	0	75	100	0	250	0.47
<i>Cyclocypris pubera</i>	100	50	50	25	25	25	75	0	0	350	0.66
<i>Cyclocypris serena</i>	0	0	100	25	0	0	0	25	0	150	0.28
<i>Cyclocypris obliqua</i>	25	0	0	0	0	0	0	0	0	25	0.05
Total	12500	9425	11100	5075	5575	3975	2650	1875	975	53150	100.00

Table 2: Relative major zooplankton taxa occurrence at Asejire Reservoir

Taxa	Sampling Stations									Total
	A	B	C	D	E	F	G	H	I	
Rotifer	58	50	44	37	45	36	36	23	18	347
Copepoda	15	13	13	13	13	12	9	8	1	97
Cladocera	15	17	17	15	17	9	8	4	1	103
Insecta	4	3	6	1	3	3	1	2	1	24
Protozoa	3	3	2	0	1	0	2	2	0	13
Ostracoda	2	3	4	2	1	2	3	4	1	22
Total	97	89	86	68	80	62	59	43	22	606

3.2 Zooplankton abundance and group dominance

The relative abundances of the different zooplankton species and the total zooplankton per station are given in Table 3. Stations A and C had the highest abundance of 12500 and 11100 (both at the riverine zone), while the lowest abundance was recorded in the lacustrine zone (Stations I and H) with abundance of 975 and 1875 individuals. *Keratella cochlearis* had the highest abundance with 2750 individuals (5.17%), followed by *Keratella tropica* with 2425 individuals (4.56%) and Copepod nauplius larvae with individual count of 1900 (3.57%). The following species had the least abundance during the sampling regime: *Squatinella mutica*, *Lecane inopinata*, *Trichocerca capusilla*, *Holopedium gibberum*, *Thermocyclops ermini*, *Halicyclops troglodytes*, *Hemicypris ovata* and *Cyclocypris obliqua*. Zooplankton was most abundant at the upper basin zone (33025 individuals), followed by the mid zone (14625 individuals) while the lacustrine zone (lower reach) recorded the lowest abundance (5500 individuals). Rotifera had the highest number of

individuals (33775) collected from the study area, followed by Copepoda (8450), Cladocera (7450), Insecta (1625) and Ostracoda (1075), while Protozoa with 775 individuals has the least number of encountered species during the study. The order of quantitative dominance among the groups was Rotifera > Copepoda > Cladocera > Insecta > Ostracoda > Protozoa in terms of individual distribution among the major taxa.

Table 3: Relative abundance of major taxa at Asejire Reservoir sampling stations

Taxa	A	B	C	D	E	F	G	H	I	Total
Rotifer	8375	5975	7225	3350	3350	2250	1575	1000	675	33775
Copepoda	1700	1650	1550	800	1275	825	375	250	25	8450
Cladocera	1800	1250	1675	775	800	575	300	175	100	7450
Insecta	350	125	350	100	100	250	100	100	150	1625
Protozoa	150	300	100	0	25	0	50	150	0	775
Ostracoda	125	125	200	50	25	75	250	200	25	1075
Total	12500	9425	11100	5075	5575	3975	2650	1875	975	53150

3.3 Zooplankton community structure

Zooplankton species diversity and evenness indices per station are shown in Tables 4 and 5, while the diversity among the taxa using species occurrence and abundance are shown in Tables 6 and 7. The highest species diversity was recorded at Station I, followed by Stations D and C, while Station E had the lowest species diversity according to the Shannon–Wiener species diversity index. Station D1 had the highest species diversity according to the Simpson and the Margalef indices.

Table 4: Diversity indices of the major taxa in Asejire Reservoir sampling stations

Indices	A	B	C	D	E	F	G	H	I
Taxa	6	6	6	5	6	5	6	6	5
Individuals	12500	9425	11100	5075	5575	3975	2650	1875	975
Dominance	0.4892	0.4515	0.4673	0.4844	0.4343	0.3887	0.3968	0.3316	0.5148
Shannon indx	1.0180	1.0860	1.0640	0.9753	1.0430	1.1770	1.2540	1.4220	0.9640

Simpson indx	0.5108	0.5485	0.5327	0.5156	0.5657	0.6113	0.6032	0.6684	0.4852
Menhinick	0.0537	0.0618	0.0570	0.0702	0.0804	0.0793	0.1166	0.1386	0.1601
Margalef	0.5300	0.5464	0.5368	0.4688	0.5796	0.4826	0.6343	0.6634	0.5812
Equitability	0.5681	0.6063	0.5936	0.6060	0.5819	0.7313	0.6998	0.7938	0.5990
Fisher alpha	0.6037	0.6234	0.6119	0.5473	0.6640	0.5643	0.7322	0.7693	0.6891
Berger-Parker	0.6700	0.6340	0.6509	0.6601	0.6009	0.5660	0.5943	0.5333	0.6923

Table 5: Diversity indices of the different species in Asejire Reservoir sampling stations

Indices	A	B	C	D	E	F	G	H	I
Occurrence	97	89	86	68	80	62	59	43	22
Individuals	12500	9425	11100	5075	5575	3975	2650	1875	975
Dominance	0.0235	0.0347	0.0276	0.0391	0.0289	0.0240	0.0244	0.0361	0.0664
Shannon indx	4.1460	3.9180	4.0050	3.8120	3.9740	3.9190	3.8920	3.5640	2.9120
Simpson indx	0.9765	0.9653	0.9724	0.9609	0.9711	0.9760	0.9756	0.9639	0.9336
Menhinick	0.8676	0.9167	0.8163	0.9545	1.0710	0.9834	1.1460	0.9930	0.7046
Margalef	10.180	9.6160	9.1250	7.8530	9.1580	7.3600	7.3580	5.5730	3.0510
Equitability	0.9063	0.8729	0.8990	0.9034	0.9069	0.9496	0.9544	0.9476	0.9422
Fisher alpha	14.320	13.600	12.690	11.100	13.230	10.430	10.700	7.8460	4.0000
Berger-Parker	0.0680	0.0955	0.0856	0.1478	0.0807	0.0629	0.0566	0.1067	0.1538

Table 6: Diversity indices of the major taxa in Asejire Reservoir based on species occurrence

Taxa	Rotifer	Copepoda	Cladocera	Insecta	Protozoa	Ostracoda
Station	9	9	9	9	6	9
Individuals	33775	8450	7450	1625	775	1075
Dominance	0.1661	0.1564	0.1677	0.1460	0.2466	0.1585
Shannon indx	1.9460	1.9480	1.9260	2.0530	1.5550	1.9690
Simpson indx	0.8339	0.8436	0.8323	0.8540	0.7534	0.8415
Menhinick	0.0490	0.0979	0.1043	0.2233	0.2155	0.2745
Margalef	0.7672	0.8848	0.8973	1.0820	0.7516	1.1460
Equitability	0.8858	0.8865	0.8767	0.9343	0.8678	0.8960
Fisher alpha	0.8498	0.9948	1.0110	1.2560	0.8855	1.3470
Berger-Parker	0.2480	0.2012	0.2416	0.2154	0.3871	0.2326

Table 7: Diversity indices of the major taxa in Asejire Reservoir based on species abundance

Taxa	Rotifer	Copepoda	Cladocera	Insecta	Protozoa	Ostracoda
Stations	9	9	9	9	6	9
Individuals	347	97	103	24	13	22
Dominance	0.1216	0.1266	0.1394	0.1493	0.1834	0.1322
Shannon indx	2.1470	2.0980	2.0360	2.0290	1.7380	2.0980
Simpson indx	0.8784	0.8734	0.8606	0.8507	0.8166	0.8678
Menhinick	0.4831	0.9138	0.8868	1.8370	1.6640	1.9190
Margalef	1.3680	1.7490	1.7260	2.5170	1.9490	2.5880
Equitability	0.9772	0.9549	0.9265	0.9236	0.9700	0.9550
Fisher alpha	1.6880	2.4230	2.3720	5.2300	4.3220	5.6850
Berger-Parker	0.1671	0.1546	0.1650	0.2500	0.2308	0.1818

Discussion

The zooplankton recorded in this study are mostly cosmopolitan freshwater species which had been previously reported elsewhere in Nigeria by several workers such as [26, 27, 28, 10, 1, 19, 29, 21, 30, 49, 32]. Apart from the commonly reported taxa of Rotifers, Cladocera and Copepoda, other Nigerian freshwater zooplankton taxa encountered during the study were Insect larvae, Protozoa and Ostracoda. These taxa were found in few stations and with lower abundance compared to the Rotifers, Cladocerans and Copepoda. A similar trend observed by [33] in the Jamieson River in South-western Nigeria. As observed by [34], the rarity of Ostracoda planktonic existence is dependent upon the other organisms which they feed on. Chaoborus, Chironomidae and other insects' larvae residency as zooplankton in water is limited as most soon migrate to nekton existence during their adult stage.

The one hundred and forty-six (146) zooplankton taxa

comprising of eighty (80) species of Rotifers, twenty four (24) species of Copepoda, twenty two (22) species of Cladocera, Seven species (07) of Protozoa, seven (07) species of Ostracoda and six (06) species of Insecta larvae in this study indicates that Asejire Reservoir is rich in zooplankton and support the assertion that standing water (reservoir) is a good habitat for zooplankton made by [35, 36]. The abundance and occurrence also indicates the species tolerance to environmental stress, resources availability, low competition and predation.

The Rotifera taxa was the dominant group with 80 species and accounting for over fifty percent of the total occurrence of the zooplankton at Asejire Reservoir. Like many other previous studies in Nigeria freshwater bodies, members of this Phylum have been noted to dominate the Nigerian freshwater zooplankton as previously reported by [37] and [38]. The success of rotifers as zooplankton has been attributed to ability to adapt to environmental changes, their parthenogenetic

reproduction, short developmental rates and presence of transparent lorica which aid their escape from predators as noted by [39, 40, 41, 42, 43, 44] as well as [45].

The different indices used to determine the community structure of zooplankton indicated high biodiversity status at all stations. Shannon–Wiener diversity values varied from 2.91 – 4.16 while the Margalef Index varied from 3.05 – 10.18. According to [46], the higher the values, the healthier the community. Margalef's water quality index values greater than 3.0 indicate clean conditions, therefore values greater than 3.0 can thus be regarded as having clean conditions. The overall Margalef's index of the lake was 4.15, which indicated that the reservoir water was generally unpolluted [47] explained that values above 3.0 show a stable and balanced habitat while values under 1.0 indicate pollution and degradation of habitat structure. Based on the Shannon–Wiener and Margalef index for zooplankton community structure, all the stations had good community structure and could also be considered as being a good indicator of the reservoir.

Some pollution indicator species such as *Asplanchna brightwelli*, *Brachionus angularis*, *B. falcatus*, *Filinia terminalis* Chaoborus and Chironomid larvae were however recorded in the reservoir during the study. Their presence suggests that the lake is mesotrophic. This could be as a result of some anthropogenic activities around the reservoir and their occurrence could be an indication that the reservoir has some organic pollutants as indicated by [7, 48].

4. Conclusion

Asejire Reservoir represents an important source of potable water supply for the inhabitants of Oyo and Osun States in the Southwest Nigeria. The zooplankton assemblage was diverse and cosmopolitan and represented species that have been reported in ecologically equivalent ecosystems in Nigeria. The community was dominated by the Rotifers in terms of the number of species and overall abundance, with *Keratella* and *Branchionus spp.* as the most important species. The overall occurrence, abundance and diversity of zooplankton was relatively high. Few indicator species such as *Asplanchna brightwelli*, *Brachionus angularis*, *B. falcatus*, *Filinia terminalis* Chaoborus and Chironomid larvae were encountered and this indicates the presence of pollutants in the reservoir and therefore robust and comprehensive monitoring program need to be instituted to arrest such negative threat to the pristine state of the reservoir.

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